CLAIMS

1. (Original) A wireless communications device for transmitting signals in a first plurality of transmit frequency bands and for receiving signals in a second plurality of receive frequency bands, the wireless communications device comprising:

an antenna for transmitting signals to and receiving signals from a wireless communications network; and

an adjustable matching network selectively connecting the antenna to a select one of a third plurality of transmit power amplifiers corresponding of the first plurality of transmit frequency bands for signal transmission, the adjustable matching network matching an impedance of the antenna to the select one transmit power amplifier.

2. (Original) The wireless communications device of claim 1, wherein the adjustable matching network selectively connects the antenna to a select one of a fourth plurality of receive bandpass filters corresponding to the second plurality of receive frequency bands for signal reception, the adjustable matching network matching the impedance of the antenna to the select one receive bandpass filter.

3. (Original) The wireless communications device of claim 1, wherein the first plurality of transmit frequency bands is equal to the second plurality of receive frequency bands.

4. (Original) The wireless communications device of claim 1, wherein the third plurality of transmit power amplifiers is less than the first plurality of transmit frequency bands, with at least one transmit power amplifier operating in at least two transmit frequency bands.

5. (Original) The wireless communications device of claim 1, wherein the adjustable matching network comprises a transmit band matching network for each of the first plurality of transmit frequency bands, each of the transmit band matching networks connected to a respective one of the third plurality of transmit power amplifiers and selectively connectable to the antenna, wherein each of the transmit band matching networks are configured to optimize antenna impedance matching for its corresponding transmit frequency band.

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6. (Original) The wireless communications device of claim 2, wherein the adjustable matching network comprises a switch selectively connecting the antenna to either (a) one of the third plurality of transmit power amplifiers, or (b) one of the fourth plurality of receive bandpass filters, the switch operating during frame periods of a Time Division Multiple Access signal format associated with the wireless communications network.

7. (Original) The wireless communications deice of claim 6, wherein the switch comprises either a Gallium Arsenide field effect transistor switch or a PIN diode switch.

8. (Original) The wireless communications device of claim 1, wherein the adjustable matching network comprises a first bank of electromechanical switches selectively connecting the antenna to one of the third plurality of transmit power amplifiers, the first bank of electromechanical switches operational to change the antenna selective connection in response to a change in selection of one of the first plurality of transmit frequency bands.

9. (Original) The wireless communications device of claim 8, wherein the first bank of electromechanical switches comprise MicroElectronic Machines.

10. (Original) The wireless communications device of claim 2, wherein the adjustable matching network comprises a second bank of electromechanical switches selectively connecting the antenna to one of the fourth plurality of receive bandpass filters, the second bank of electromechanical switches operational to change the antenna selective connection in response to a change in selection of one of the second plurality of receive frequency bands.

11. (Original) The wireless communications device of claim 10, wherein the second bank of electromechanical switches comprise MicroElectronic Machines.

12. (Original) The wireless communications device of claim 5, wherein the transmit band matching networks comprise a single series inductor and a shunt capacitor.

13. (Original) The wireless communications device of claim 2, wherein the adjustable matching network comprises a receive band matching network for each of the second plurality of receive frequency bands, each of the receive band matching networks connected to a respective one of the fourth plurality of receive bandpass filters and selectively connectable to the antenna, wherein each of the receive band matching networks are configured to optimize antenna impedance matching for its corresponding receive frequency band.

14. (Original) The wireless communications device of claim 13, wherein the receive band matching networks comprise a single series inductor and a shunt capacitor.

15. (Original) The wireless communications device of claim 2, wherein the adjustable matching network comprises:

a variable matching network connected to the antenna; and

a transmit/receive switch having common, receive output and transmit input terminals, and operable between transmit and receive positions, the transmit/receive switch having its common terminal connected to the variable matching network, the transmit/receive switch receive output terminal selectively connectable to a select one of the fourth plurality of receive bandpass filters, and the transmit/receive switch transmit input terminal selectively connectable to a select one of the third plurality of transmit power amplifiers.

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16. (Original) The wireless communications device of claim 15, wherein the adjustable matching network further comprises a first bank of electromechanical switches connected between the transmit/receive switch transmit input terminal and the third plurality of transmit power amplifiers for selectively connecting the antenna to a select one of the third plurality of transmit power amplifiers, the first bank of electromechanical switches operational to change the antenna selective connection in response to a change in selection of one of the first plurality of transmit frequency bands.

17. (Original) The wireless communications device of claim 15, wherein the adjustable matching network further comprises a second bank of electromechanical switches connected between the transmit/receive switch receive output terminal and the fourth plurality of receive bandpass filters for selectively connecting the antenna to a select one of the fourth plurality of receive bandpass filters, the second bank of electromechanical switches operational to change the antenna selective connection in response to a change in selection of one of the second plurality of receive frequency bands.

18. (Original) The wireless communications device of claim 15, wherein the transmit/receive switch is operational at a frame rate of a Time Division Multiple Access signal format utilized by the wireless communications network.

19. (Original) The wireless communications device of claim 15, wherein the variable matching network comprises step-switched reactances matching an impedance of the antenna to a selected transmit power amplifier.

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20. (Original) The wireless communications device of claim 19, wherein the step-switched reactances each comprise a plurality of reactances in a binary ratio of reactance value, with each of the plurality of reactances having an associated switch.

21. (Original) The wireless communications device of claim 15, wherein the adjustable matching network further comprises:

an impedance mismatch measuring and quantizing unit measuring forward and reflected power of a signal transmitted in a selected one of the first plurality of transmit frequency bands corresponding to a selected one of the third plurality of transmit power amplifiers, and generating signals providing a quantized indication of antenna impedance mismatch; and

a control processing unit receiving and processing the quantized impedance mismatch indication signals and providing adjustment control signals to the variable matching network to adjust the variable matching network to achieve an impedance match of the antenna to the selected transmit power amplifier.

22. (Original) The wireless communications device of claim 21, wherein the quantized impedance mismatch indication signals are generated by the impedance mismatch measuring and quantizing unit during a transmit slot of a Time Division Multiple Access frame period.

23. (Original) The wireless communications device of claim 21, wherein the control processing unit provides the adjustment control signals to the variable matching network during a portion of a Time Division Multiple Access frame period not used by the wireless communications device for either transmission or reception.

24. (Original) The wireless communications device of claim 2, wherein the adjustable matching network comprises:

a transmit/receive switch having common, receive output and transmit input terminals, and operable between transmit and receive portions, the transmit/receive switch having its common terminal connected to the antenna;

a variable receive matching network connected to the receive output of the transmit/receive switch and selectively connected to a select one of the fourth plurality of receive bandpass filters; and

a variable transmit matching network connected to the transmit input terminal of the transmit/receive switch and selectively connected to a select one of the third plurality of transmit power amplifiers.

25. (Original) The wireless communications device of claim 24, wherein the adjustable matching network further comprises:

a first bank of electromechanical switches connected between the variable transmit matching network and the third plurality of transmit power amplifiers for selectively connecting the variable transmit matching network to a select one of the third

plurality of transmit power amplifiers, the first bank of electromechanical switches operational to change the selective connection in response to a change in selection of one of the first plurality of transmit frequency bands; and

a second bank of electromechanical switches connected between the variable receive matching network and the fourth plurality of receive bandpass filters for selectively connecting the variable receive matching network to a select one of the fourth plurality of receive bandpass filters, the second bank of electromechanical switches operational to change the selective connection in response to a change in selection of one of the second plurality received frequency bands.

26. (Original) The wireless communications device of claim 25, wherein the first and second banks of electromechanical switches comprise MicroElectronic Machines.

27. (Original) The wireless communications device of claim 24, wherein the adjustable matching network further comprises:

an impedance mismatch measuring and quantizing unit measuring forward and reflected power of a signal transmitted in a selected one of the first plurality of transmit frequency bands corresponding to a selected one of the third plurality of transmit power amplifiers, and generating signals providing a quantized indication of antenna impedance mismatch; and

a control processing unit receiving and processing the quantized impedance mismatch indication signals and providing adjustment control signals to the variable transmit matching network to adjust the variable transmit matching network to achieve an impedance match of the antenna to the selected power amplifier.

28. (Original) The wireless communications device of claim 27, wherein the quantized impedance mismatch indication signals are generated by the impedance mismatch measuring and quantizing unit during a transmit slot of a Time Division Multiple Access period.

29. (Original) The wireless communications device of claim 27, wherein the control processing unit provides the adjustment control signals to the variable transmit matching network during a portion of a Time Division Multiple Access frame period not used by the wireless communications device for either transmission or reception.

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30. (Original) The wireless communications device of claim 24, wherein the variable receive matching network includes either a set of fixed matching components for each of the second plurality of receive frequency bands, or step-switched reactances matching an impedance of the antenna to a selected receive bandpass filter in response to switch control signals from a control processing unit.

31. (Original) The wireless communications device of claim 24, wherein the variable transmit matching network includes either a set of fixed matching components for each of the first plurality of transmit frequency bands, or step-switched reactances matching an impedance of the antenna to a selected transmit power amplifier in response to switch control signals from a control processing unit.

32. (Original) The wireless communications device of claim 30, wherein the control processing unit stores predetermined values for the switch control signals for each of the second plurality of received frequency bands.

33. (Original) The wireless communications device of claim 27, wherein the control processing unit inhibits adjustment of the variable transmit matching network when the quantized impedance mismatch indication signals indicate an antenna impedance mismatch within a predetermined limit.

34. (Original) A wireless communication device for transmitting and receiving signals in multiple transmit and receive frequency bands using Time Division Multiple Access (TDMA) signal formats, the wireless communications device comprising:

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an antenna for transmitting signals to and receiving signals from a wireless communications network;

a transmit/receive switch selectively coupling the antenna to a transmit signal path during a transmit time slot of a frame period of the TDMA signal format, and selectively coupling the antenna to a receive signal path during a receive time slot of the TDMA frame period;

a variable matching network connected in the transmit signal path between the antenna and a selected transmit power amplifier corresponding to a selected transmit frequency band;

an impedance mismatch measuring and quantizing unit connected in the transmit signal path between the selected transmit power amplifier and the variable matching network, the impedance mismatch measuring and quantizing unit measuring forward and reflected power of a signal transmitted on the selected transmit frequency band, and generating mismatch indication signals providing a quantized indication of antenna impedance mismatch, the impedance mismatch measuring and quantizing unit generating the mismatch indication signals during the transmit time slot of the TDMA frame period; and

a control processing unit receiving and processing the mismatch indication signals and providing adjustment control signals to the variable matching network during a portion of the TDMA frame period not utilized by the wireless communications device for transmission.

35. (Original) The wireless communications device of claim 34, wherein the adjustment control signals are provided by the control processing unit to the variable matching network during a portion of the TDMA frame period not used by the wireless communications device for reception.

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36. (Original) The wireless communications device of claim 34, wherein the mismatch indication signals include a first bit indicative of whether a reflection coefficient magnitude developed from the measured forward and reflected power it is less than or greater than a predetermined value.

37. (Original) The wireless communications device of claim 36, wherein if the first bit of the mismatch indication signals indicate a reflection coefficient less than the predetermined value, the control processing unit does not provide adjustment control signals to the variable matching network.

38. (Original) The wireless communications device of claim 34, wherein the mismatch indication signals provide a coarse indication of reflection coefficient phase.

39. (Original) The wireless communications device of claim 38, wherein the mismatch indication signals include a 2-bit quadrant indication portion indicating in which quadrant of a complex plane the reflection coefficient lies.

40. (Original) The wireless communication device of claim 39, wherein the 2-bit quadrant indication portion is processed by the control processing unit to output the adjustment control signals from a precomputed look-up table.

41. (New) A method of optimizing impedance between a transceiver and an antenna in a wireless communications device comprising:

measuring a signal to determine a complex reflection coefficient indicative of a quality of an impedance match between a transceiver and an antenna at a selected frequency band;

detecting an impedance mismatch between the transceiver and the antenna at the selected frequency band; and

automatically adjusting a variable impedance matching network in the wireless communications device, during an idle period of communications, to minimize the impedance mismatch at the selected frequency band.

42. (New) The method of claim 41 wherein measuring a signal to determine a complex reflection coefficient comprises measuring an amplitude and phase of a reflected power of a transmitted signal during a TDMA transmit slot.

43. (New) The method of claim 42 wherein measuring a signal to determine a complex reflection coefficient further comprises measuring a forward power of the transmitted signal during the TDMA transmit slot.

44. (New) The method of claim 43 wherein detecting an impedance mismatch between the transceiver and the antenna at the selected frequency band comprises determining the

magnitude of the forward power relative to the magnitude of the reflected power of the transmitted signal.

45. (New) The method of claim 41 wherein detecting an impedance mismatch between the transceiver and the antenna at the selected frequency band comprises quantizing the complex reflection coefficient into one of a predetermined number of quality levels.

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46. (New) The method of claim 45 wherein detecting an impedance mismatch between the transceiver and the antenna at the selected frequency band is based on the quality levels.

47. (New) The method of claim 46 wherein quantizing the complex reflection coefficient into one of a predetermined number of quality levels comprises quantizing the complex reflection coefficient into one of a plurality of amplitudes and one of a plurality of phases.

48. (New) The method of claim 45 further comprising averaging a plurality of quantized complex reflection coefficients to determine an average complex reflection coefficient value.

49. (New) The method of claim 48 further comprising inputting the averaged and complex reflection coefficient values into a controller.

50. (New) The method of claim 41 wherein automatically adjusting a variable impedance matching network during an idle period of communications comprises increasing or decreasing capacitance in the variable impedance matching network.

51. (New) The method of claim 41 wherein automatically adjusting a variable impedance matching network during an idle period of communications to minimize the impedance mismatch occurs during an idle slot of a TDMA frame.

52. (New) A method of optimizing impedance between a transceiver and an antenna in a wireless communications device comprising:

measuring a forward power and a reflected power of a transmitted signal transmitted on a selected transmit frequency band;

generating an impedance mismatch signal to a controller during the transmit time slot of the TDMA frame based on the quantized forward power and reflected power;

adjusting a variable impedance matching network responsive to the impedance mismatch signal, during an idle period of communications in the TDMA frame, to minimize an impedance mismatch between the antenna and a transceiver at the selected frequency.

53. (New) The method of claim 52 wherein adjusting a variable impedance matching network responsive to the impedance mismatch signal comprises generating an adjustment control signal to the variable matching network.

54. (New) The method of claim 52 further comprising quantizing the forward power and the reflected power of the transmitted signal transmitted on the selected transmit frequency band;

55. (New) The method of claim 54 further comprising determining a complex reflection coefficient from the quantized forward power and reflected power of the transmitted signal.

56. (New) The method of claim 55 wherein generating an impedance mismatch signal to a controller comprises generating a first bit indicative of whether the complex reflection coefficient is less than or greater than a predetermined value.

57. (New) The method of claim 56 further comprising generating the adjustment control signal if the reflection coefficient is greater than the predetermined value.

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58. (New) The method of claim 55 wherein generating an impedance mismatch signal to a controller comprises generating a coarse indication of the phase of the complex reflection coefficient.

59. (New) The method of claim 58 wherein generating an impedance mismatch signal to a controller comprises generating a two-bit quadrant indication representative of a quadrant in a complex plane in which the complex reflection coefficient lies.

60. (New) The method of claim 59 further comprising comparing the two-bit quadrant indication with predetermined values in a lookup table.

61. (New) The method of claim 60 further comprising generating the adjustment control signal based on the predetermined values in the lookup table

62. (New) The method of claim 52 further comprising selectively coupling an antenna to a receive signal path during a receive time slot of a TDMA frame, and a transmit signal path during a transmit time slot of a TDMA frame.

63. (New) An impedance optimization circuit for a wireless communications device comprising:

a controller programmed to:

measure a forward power and a reverse power of a transmitted signal on a selected frequency band to determine the quality of an impedance match between a transceiver and an antenna at the selected frequency band;

detect an impedance mismatch between the transceiver and the antenna at the selected frequency band; and

adjust an variable impedance matching network, during an idle period of communications, to minimize the impedance mismatch between the transceiver and the antenna at the selected frequency band.

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